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WRF idealized-roughness response: PBL scheme and resolution dependence

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The performance and behavior of WRF can depend quite crucially upon its modelled and input boundary conditions; in the planetary boundary layer (PBL) bordering the Earth's surface, WRF's behavior and reaction to the bottom boundary is driven to a great extent by the PBL scheme chosen.
For applications in the atmospheric boundary layer that depend on the modelled flow, such as pollution/dispersion modelling or wind energy, the surface roughness is a primary parameter dictating WRF's output at heights up to several hundred meters from the surface (or more).
The response of WRF to input surface roughness varies with PBL scheme and also resolution.
Further, the response of WRF varies yet more dramatically for changes in surface roughness, the most extreme being coastlines.

Here we evaluate and explain WRF's response to roughness and roughness changes for several (most) commonly-used PBL schemes, as a function of resolution.
Output wind profiles for idealized roughness changes are used to show that—in effect—WRF "senses" a different roughness depending on PBL scheme and resolution, per roughness input. We systematically show how different roughness inputs are needed to obtain the same effective roughness (via wind shear) for a given WRF/PBL setup; this also includes some wind speed dependence. We offer a first step towards mapping input roughness fields, in order to obtain consistent wind-field output across multiple PBL schemes and resolutions.